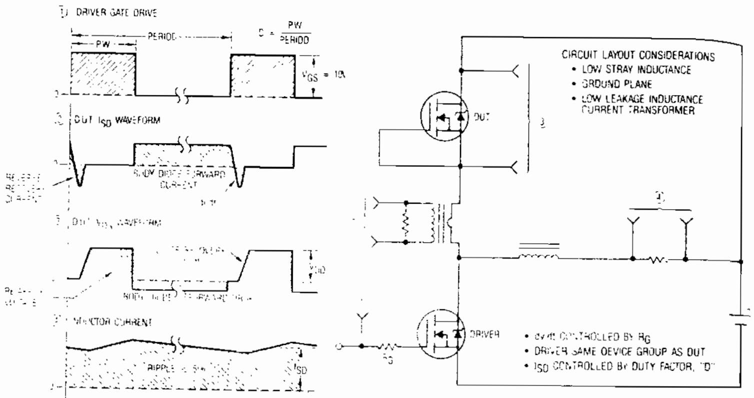


Fig. 17 — Peak Diode Recovery dv/dt Test Circuit

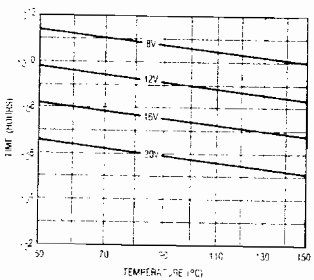


Fig. 18 — Typical Time to Accumulated 1% Gate Failure

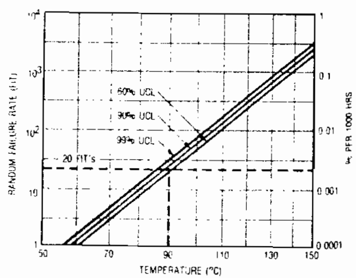


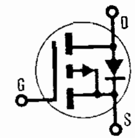
*Fig. 19 — Typical High Temperature Reverse Bias (HTRB) Failure Rate

*The data shown is correct as of April 15, 1987. This information is updated on a quarterly basis. For the latest reliability data, please contact your local IR field office.

INTERNATIONAL RECTIFIER IOR

HEXFET® TRANSISTORS IRF9510 IRF9511 IRF9512 IRF9513

P-CHANNEL 100 VOLT POWER MOSFETs



-100 Volt, 1.2 Ohm HEXFET TO-220AB Plastic Package

The HEXFET technology is the key to International Rectifier's advanced line of power MOSFET transistors. The efficient geometry and unique processing of the HEXFET design achieve very low on-state resistance combined with high transconductance and extreme device ruggedness.

The P-Channel HEXFETs are designed for applications which require the convenience of reverse polarity operation. They retain all of the features of the more common N-Channel HEXFETs such as voltage control, very fast switching, ease of paralleling, and excellent temperature stability. The P-Channel IRF9510 device is an approximate electrical complement to the N-Channel IRF510 HEXFET.

P-Channel HEXFETs are intended for use in power stages where complementary symmetry with N-Channel devices offers circuit simplification. They are also very useful in drive stages because of the circuit versatility offered by the reverse polarity connection. Applications include motor control, audio amplifiers, switched mode converters, control circuit and pulse amplifiers.

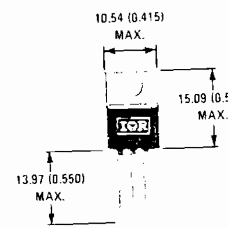
Features:

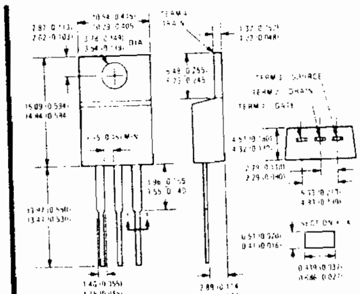
- P-Channel Versatility
- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- Excellent Temperature Stability

Product Summary

Part Number	V_{DS}	$R_{DS(on)}$	I_D
IRF9510	-100V	1.2Ω	-3.0A
IRF9511	-60V	1.2Ω	-3.0A
IRF9512	-100V	1.6Ω	-2.5A
IRF9513	-60V	1.6Ω	-2.5A

CASE STYLE AND DIMENSIONS





Case Style TO-220AB
All Dimensions in Millimeters and (Inches)

Absolute Maximum Ratings

Parameter		IRF9510	IRF9511	IRF9512	IRF9513	Units
V_{DS}	Drain - Source Voltage ①	-100	-60	-100	-60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 20 kΩ) ①	-100	-60	-100	-60	V
I_D @ T_C = 25°C	Continuous Drain Current	-3.0	-3.0	-2.5	-2.5	A
I_D @ T_C = 100°C	Continuous Drain Current	-2.0	-2.0	-1.5	-1.5	A
I_{DM}	Pulsed Drain Current ③	-12	-12	-10	-10	A
V_{GS}	Gate - Source Voltage	± 20				V
P_D @ T_C = 25°C	Max. Power Dissipation	20 (See Fig. 14)				W
	Linear Derating Factor	0.16 (See Fig. 14)				W/K④
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH -12	-12	-10	-10	A
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

Electrical Characteristics @T_C = 25°C (Unless Otherwise Specified)

	Parameter	Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	IRF9510 IRF9512	-100	–	–	V	V_{GS} = 0V
		IRF9511 IRF9513	-60	–	–	V	I_D = -250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	-2.0	–	-4.0	V	V_{DS} = V_{GS}, I_D = -250μA
I_{GSS}	Gate - Source Leakage Forward	ALL	–	–	-500	nA	V_{GS} = -20V
I_{GDS}	Gate - Source Leakage Reverse	ALL	–	–	500	nA	V_{GS} = 20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	-250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	-1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	IRF9510 IRF9511	-3.0	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = -10V
		IRF9512 IRF9513	-2.5	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	IRF9510 IRF9511	–	1.0	1.2	Ω	V_{GS} = -10V, I_D = -1.5A
		IRF9512 IRF9513	–	1.2	1.6	Ω	
g_{fs}	Forward Transconductance ②	ALL	0.8	1.1	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)max.}$, I_D = -1.5A
C_{iss}	Input Capacitance	ALL	–	180	250	pF	V_{GS} = 0V, V_{DS} = -25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	85	100	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	30	35	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	15	30	ns	V_{DD} = -50V, I_D = -1.5A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	30	60	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	20	40	ns	
t_f	Fall Time	ALL	–	20	40	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	8.5	11	nC	V_{GS} = -15V, I_D = -4A, V_{DS} = 0.8V Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	3.8	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	4.7	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die. — Modified MOSFET symbol showing the internal device inductances.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Thermal Resistance

R_{thJC}	Junction-to-Case	ALL	–	–	6.4	K/W④	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W④	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W④	Typical socket mount

Source-Drain Diode Ratings and Characteristics

I_S	Continuous Source Current (Body Diode)	IRF9510 IRF9511	–	–	-3.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		IRF9512 IRF9513	–	–	-2.5	A	
I_{SM}	Pulse Source Current (Body Diode) ③	IRF9510 IRF9511	–	–	-12	A	
		IRF9512 IRF9513	–	–	-10	A	
V_{SD}	Diode Forward Voltage ②	IRF9510 IRF9511	–	–	-5.5	V	T_C = 25°C, I_S = -3.0A, V_{GS} = 0V
		IRF9512 IRF9513	–	–	-5.3	V	T_C = 25°C, I_S = -2.5A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	120	–	ns	T_J = 150°C, I_F = -3.0A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	6.0	–	μC	T_J = 150°C, I_F = -3.0A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).
④ K/W = °C/W
W/K = W/°C

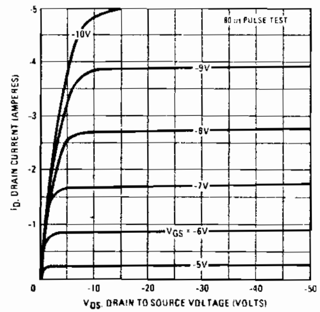


Fig. 1 – Typical Output Characteristics

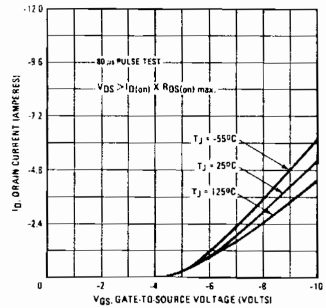


Fig. 2 – Typical Transfer Characteristics

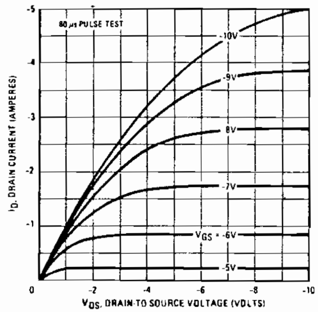


Fig. 3 – Typical Saturation Characteristics

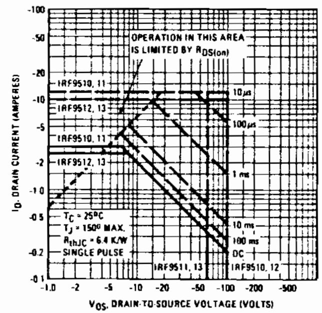


Fig. 4 – Maximum Safe Operating Area

TO-220

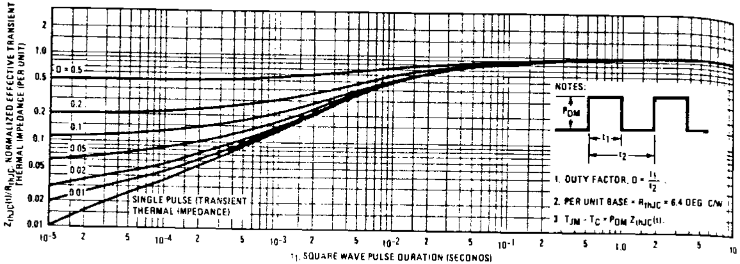


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

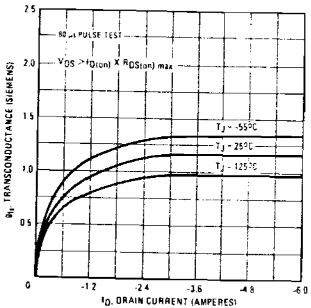


Fig. 6 – Typical Transconductance Vs. Drain Current

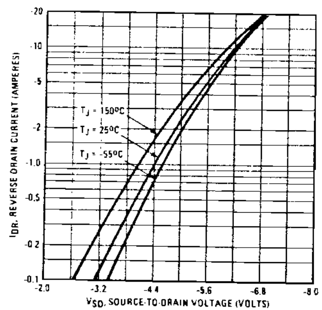


Fig. 7 – Typical Source-Drain Diode Forward Voltage

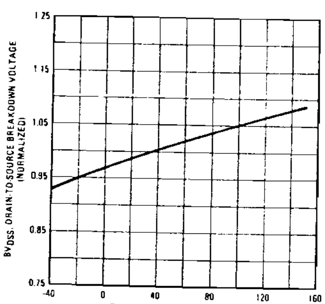


Fig. 8 – Breakdown Voltage Vs. Temperature

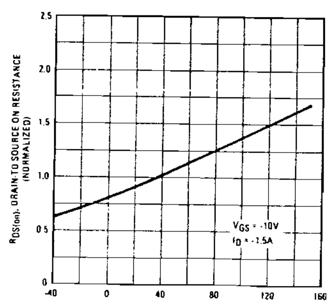


Fig. 9 – Normalized On-Resistance Vs. Temperature

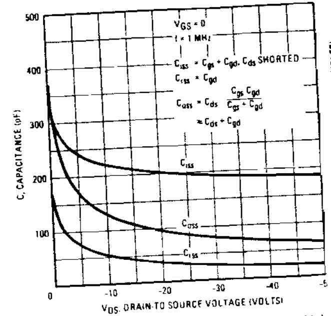


Fig. 10 – Typical Capacitance Vs. Drain-to-Source Volt

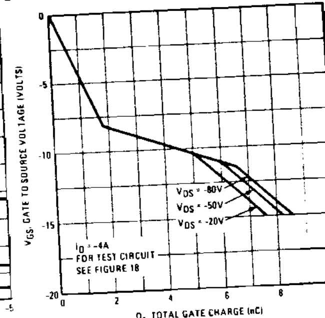


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

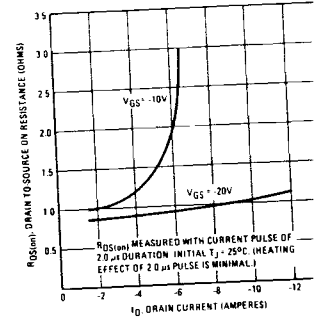


Fig. 12 – Typical On-Resistance Vs. Drain Curre

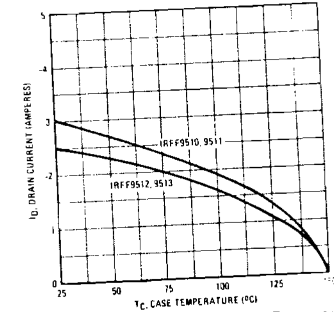


Fig. 13 – Maximum Drain Current Vs. Case Temperature

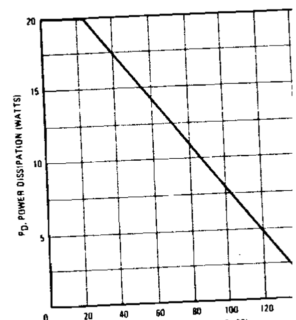


Fig. 14 – Power Vs. Temperature Derating (

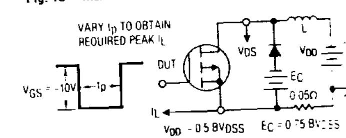


Fig. 15 — Clamped Inductive Test Circuit

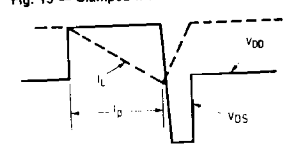


Fig. 16 — Clamped Inductive Waveforms

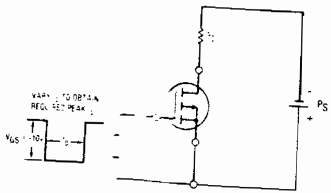


Fig. 17 — … Time Test Circuit

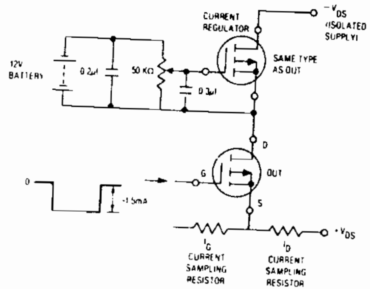


Fig. 18 — Gate Charge Test Circuit

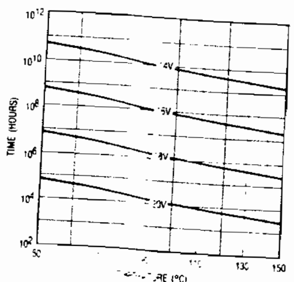


*Fig. 19 — Typical … Accumulated 1% Gate Failure

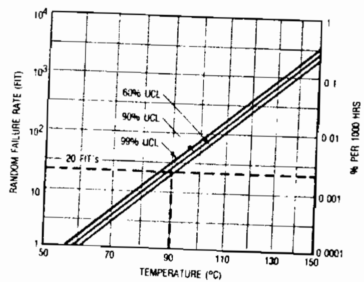
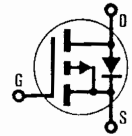


*Fig. 20 — Typical High Temperature Reverse Bias (HTRB) Failure Rate

*The data shown in corre… 1987. This information is updated on a quarterly basis. for the late… please contact your local IR field office

INTERNATIONAL RECTIFIER IOR

HEXFET® TRANSISTORS IRF9520 IRF9521 IRF9522 IRF9523



P-Channel

-100 Volt, 0.6 Ohm HEXFET TO-220AB Plastic Package

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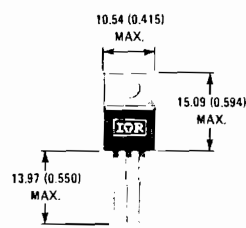
Features:

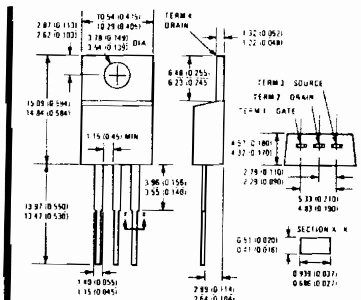
- P-Channel Versatility
- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- Excellent Temperature Stability

Product Summary

Part Number	V_{DS}	$R_{DS(on)}$	I_D
IRF9520	-100V	0.60Ω	-6.0A
IRF9521	-60V	0.60Ω	-6.0A
IRF9522	-100V	0.80Ω	-5.0A
IRF9523	-60V	0.80Ω	-5.0A

CASE STYLE AND DIMENSIONS





Case Style TO-220AB
Dimensions in Millimeters and (Inches)